REMARKS

Claims 1-17 were pending in this application. By the present Amendment, claims 1-3 have been canceled, without prejudice or disclaimer, claims 4, 6-8, 10, 14, 16 and 17 have been amended and new claims 18-21 have been added. Claims 4-21 would be pending in this application upon entry of this Amendment, with claims 18 and 21 being in independent form.

Claims 1-17 were rejected under 35 U.S.C. §103(a) as purportedly unpatentable over Ishikawa (U.S. Patent No. 6,254,213) in view of Matsuo (U.S. Patent No. 6,488,349). Claims 1-17 were rejected under 35 U.S.C. §103(a) as purportedly unpatentable over Kusunoki '912 (US 2003/0001912 A1) in view of Matsuo.

Applicant respectfully submits that the present application is allowable over the cited art, for at least the reason that the cited art does not disclose or suggest the aspects of the present application that a first drop speed is faster than an intermediate drop speed and a last drop speed is faster than both the first drop speed and the intermediate drop speed such that the last ink drop gathers the intermediate drops and ***subsequently*** merges with the first ink drop to form the large ink drop ***before*** reaching the print target medium.

Such ink drop speed relationships and merging orders are obtained in the present application by discharging the at least one intermediate ink drop at an interval ***substantially equal to (n+1/2) x Tc*** but ***NOT equal to n x Tc*** and discharging the last ink drop at an interval ***substantially equal to n x Tc*** but ***NOT equal to (n+1/2) x Tc***. Applicant submits that the combination of intervals claimed in the present application yields synergistic and unexpected results not present when discharging drops at relatively consistent intervals.

In addition, as discussed in the present application ([0114] through [0138]), superior performance (for example, larger merged droplet, greater stability, superior suppression of

residual pressure vibration, etc.) is obtained when the ink drops other than the last ink drop are discharged at an interval substantially equal to (n+1/2) x Tc but not equal to n x Tc, as compared to when adjacent driving pulses in a driving signal are spaced by an interval that is a multiple of the resonance period Tc.

Ishikawa, as understood by applicant, proposes an ink droplet jetting apparatus for jetting droplets of ink to from consecutive dots. The droplets for forming the consecutive dots are proposed by Ishikawa to be jetted continuously at a period of (N+0.5)T.

However, Ishikawa is not directed at discharging ink drops which merge together before reaching a print medium. There is simply no indication in any of the cited art that the ink droplets proposed by Ishikawa could be modified or adapted to merge before reaching a print medium without an entire redesign of the apparatus proposed by Ishikawa. To the contrary, one skilled in the art would have recognized the stark functional differences between the apparatus proposed by Ishikawa and one in which ink drops merge before reaching a print medium as a deterrent to further adaptation.

Therefore, applicant submits that one skilled in the art would not have deemed Ishikawa to be relevant to the context of the present application wherein sequential ink drops merge to form a larger ink drop prior to reaching a print target medium.

It is contended in the Office Action (page 4) that one skilled in the art would have redesigned the apparatus proposed by Ishikawa to jet ink droplets which would merge before reaching a printing medium because "the merged ink drops dry uniformly which improves the uniformity, quality, of the large ink drops."

However, no citation to any of the cited art is provided to support such contention. As discussed above, applicant respectfully submits that one skilled in the art would not have

recognized any such benefits to redesigning the apparatus proposed by Ishikawa to produce ink drops which mere before reaching a printing medium.

Moreover, Ishikawa does not disclose or suggest any drop discharge pattern other than one with relatively consistent timing. Clearly, Ishikawa does not disclose or suggest discharging one or more ink drops before a last drop at intervals of (n + ½) x Tc and discharging a last drop at intervals of n x Tc.

Matsuo, as understood by applicant, proposes an ink jet head comprising a driving signal supply means for supplying a driving voltage signal including a plurality of driving pulses to a piezoelectric element of an actuator, under a condition of $t1 \leq t2 \leq t3 \leq t0$, wherein t0 is the natural period of the actuator, t1 is a first time from a start of potential decrease in the potential decreasing waveform to an end of potential increase in the potential increasing waveform in the initial driving pulse, t2 is a second time from a start of a potential holding in a positive pressure potential holding waveform to an end of potential increase in a potential increasing waveform in the first subsequent driving pulse, t3 is a third time from a start of potential holding in a positive pressure potential holding waveform to an end of potential increase in a potential increasing waveform in the second subsequent driving pulse. The corresponding driving pulses are configured such that ink droplets are discharged from the nozzle with discharge velocity gradually increasing, resulting in ink droplets merging before striking the recording medium.

Thus, in the apparatus proposed by Matsuo, each of consecutive intervals t1, t2, t3 is longer than the preceding interval, and each interval between drops other than a last drop is ***less than or equal to*** t0, the natural period of the actuator.

Further, Matsuo teaches:

> "It is preferred that the driving signal supply means supplies the plurality of driving pulses so that the time interval

> between the driving pulses gradually increases ... so as to approach the natural period of the actuator (i.e. driving intervals < natural frequency), whereby the overall time interval of the driving pulses is shorter than that when the time interval gradually decreases so as to approach the natural period (i.e. driving intervals > natural frequency). Therefore, *it is possible to reduce the printing cycle, thereby enabling printing at a higher speed*." (Matsuo col. 2, line 63 to col. 3, line 5, emphasis added).

Therefore, Matsuo would discourage one skilled in the art from using a driving signal having discharge intervals greater than the natural frequency of the actuator. In other words, one skilled in the art would understand Matsuo to teach that using a driving signal greater than a natural frequency would increase the printing cycle, disabling printing at higher speed. Thus, it would not have been obvious to combine the teachings of Matsuo with Ishikawa or Kusunoki '912, both of which disclose discharge intervals much greater than the natural frequency of the actuator. One skilled in the art would simply not have wanted to slow a printing cycle (and potentially disable high speed printing) by increasing a period between ink drops other than a last drop to be more than a natural frequency of the actuator after reading Matsuo.

Also, Matsuo does not disclose or suggest that advantageous results can be obtained by discharging the ink drops other than the last ink at an interval substantially equal to $(n + \frac{1}{2}) \times Tc$, where n is an integer equal to or greater than 1, when sequential ink drops merge before reaching a print target medium.

Even with knowledge of Matsuo, one skilled in the art would not have looked to modify the apparatus proposed by Ishikawa or Kusunoki '912 to obtain a modified apparatus for discharging sequential ink drops wherein the sequential ink drops merge before reaching a print target medium, since such modification would have entailed a substantial overhaul of the design of the image forming apparatus.

In addition, Matsuo does not disclose or suggest discharging one or more ink drops

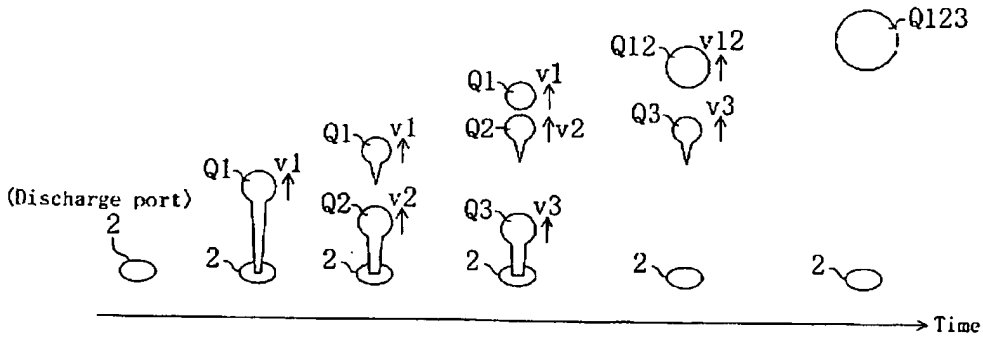
before a last drop at intervals of (n + ½) x Tc and discharging a last drop at intervals of n x Tc.

To the contrary, Matsuo proposes supplying driving pulses at timings which gradually increase to a last drop timing of less than, equal to or slightly longer than a natural period of the actuator. As described above, none of the timings proposed by Matsuo are substantially equal to (n + ½) x Tc. Therefore, the synergistic and unexpected results of the combination of discharge intervals of (n + ½) x Tc for drops other than a last drop and n x Tc for the last drop are not disclosed or suggested in any way by Matsuo.

Moreover, Matsuo does not disclose or suggest that a first drop speed is faster than an intermediate drop speed and a last drop speed is faster than both the first drop speed and the intermediate drop speed such that the last ink drop gathers the intermediate drops and ***subsequently*** merges with the first ink drop to form the large ink drop.

To the contrary, as shown in Figure 14 of Matsuo, reproduced below, Matsuo proposes that a second ink drop Q2 is discharged at a velocity v2 greater than a velocity v1 of a first ink drop Q1 in order to merge the first and second ink drops Q12 before a third ink drop Q3 merges with the combined first and second ink drop Q12.

FIG. 14



Thus, the speed relationships and merging order proposed by Matsuo bear no resemblance to those claimed in the present application. Matsuo simply does not disclose or suggest that a first drop speed is faster than an intermediate drop speed and a last drop speed is faster than both the first drop speed and the intermediate drop speed such that the last ink drop gathers the intermediate drops and ***subsequently*** merges with the first ink drop to form the large ink drop.

Kusunoki '912, as understood by applicant, proposes an ink jet recording apparatus for continuously discharging ink droplets to form consecutive dots on a print medium. Kusunoki '912 proposes that such apparatus includes a driving signal generator, wherein the driving signal generator generates an expansion pulse for increasing the capacity of the pressure chamber and a contraction pulse for reducing the capacity of the pressure chamber with a timing such that a time lag between the respective centers of the expansion pulse and the contraction pulse matches the resonance period of a meniscus generated in the nozzle by the ink in the pressure chamber.

However, as previously noted, Matsuo would strongly discourage one skilled in the art from using a driving signal having discharge intervals greater than the natural frequency of the actuator. Given such discouragement, it would not have been obvious to combine the teachings of Matsuo with Kusunoki '912 in the manner contended in the Office Action.

Further, Kusunoki '912 is directed an apparatus for discharging sequential ink droplets which do not merge before reaching a print media. For example, in paragraph [0050], Kusunoki discusses altering driving voltages of driving signals to avoid situations where "positions of impact of the ink drops vary substantially." As discussed above with reference to Ishikawa, a device configured to output ink drops which land individually on a print medium is not relevant to an image formation apparatus configured to discharge ink drops which merge before reaching

a print medium.

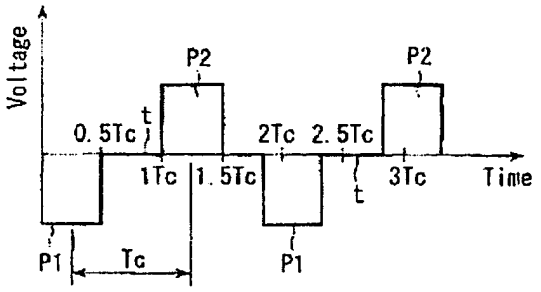
Moreover, Kusunoki '912 does not disclose or suggest discharging one or more ink drops before a last drop at intervals of (n + ½) x Tc and discharging a last drop at intervals of n x Tc.

It is contended in the Office Action that the aspect of a last drop being discharged at an interval of n x Tc after one or more drops are discharged at intervals of (n + 1/2) x Tc is disclosed by Kusunoki '912 by ink drops proposed to be jetted at intervals of 2.5 and 1.5 times the period Tc and in Figure 4.

As discussed above and extensively in the record and made explicit by the claim amendments herein, an interval of n x Tc is ***NOT*** substantially equal to (n+1/2) x Tc.

Figure 4 of Kusunoki '912, cited in the Office Action and reproduced below, does not show any pulse interval substantially equal to (n+1/2) x Tc or any pulse interval substantially equal to n x Tc (both of which are required by the claims of the present application).

FIG. 4



To the contrary, only one pulse period is shown in Figure 4 of Kusunoki '912 – a period of some duration less than 2Tc and more than 1.5Tc, but substantially equal (as the term is defined in the present application) to neither.

Applicant submits that the cited art, even when considered along with common sense and common knowledge to one skilled in the art, does ***NOT*** render unpatentable the aforementioned aspects of the present application.

Accordingly, applicant respectfully submits that independent claims 18 and 21 and the claims depending therefrom are patentable over the cited art.

In addition, with respect to new independent claim 21, applicant respectfully submits that the aspect that one or more ink drops before a last drop are discharged at an interval of (n +1/2) x Tc to suppress a pressure vibration of a pressurized ink chamber while the last drop is discharged at an interval of (n x Tc) in sync with a peak pressure vibration of the ink chamber is not disclosed or suggested by any of the cited art. As discussed above, such configuration has synergistic effects not present when drops are discharged at relatively consistent intervals.

With respect to new claim 19, applicant respectfully submits that the aspect that the sequential drops are discharged when the pressure generating means contracts the pressurized ink chamber (and at the intervals claimed in the independent claim 1 from which claim 18 depends) is not disclosed or suggested in the cited art.

Specifically, Kusunoki '912 does not disclose or suggest that any ink drops are discharged at intervals corresponding to the intervals with which the driving pulses (or chamber contractions) are generated. For example, in Figure 5 of Kusunoki '912, reproduced below, and which corresponds to the timings of the pulses shown in Figure 4, reproduced above, at the conclusion of the proposed contraction pulse at 1.5Tc, no ink drop has been discharged (Fig. 5D).

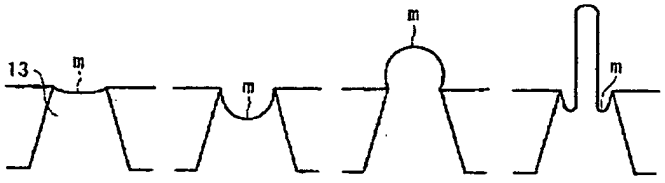


FIG. 5A FIG. 5B FIG. 5C FIG. 5D

With respect to new claim 20, applicant respectfully submits that the aspect that the sequential drops are merged in reverse order, as described, for example, at paragraph [0130] is not disclosed or suggested in any of the cited art.

In view of the remarks hereinabove, applicant submits that the application is now in condition for allowance. Accordingly, Applicant earnestly solicits the allowance of the application.

If a petition for an extension of time is required to make this response timely, this paper should be considered to be such a petition. The Patent Office is hereby authorized to charge any fees that are required in connection with this amendment and to credit any overpayment to our Deposit Account No. 03-3125.

If a telephone interview could advance the prosecution of this application, the Examiner is respectfully requested to call the undersigned attorney.

Respectfully submitted,

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